Jet Propulsion Laboratory
California Institute of Technology

CUPID'S ARROW

Overview

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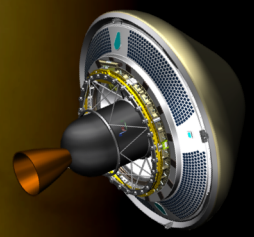
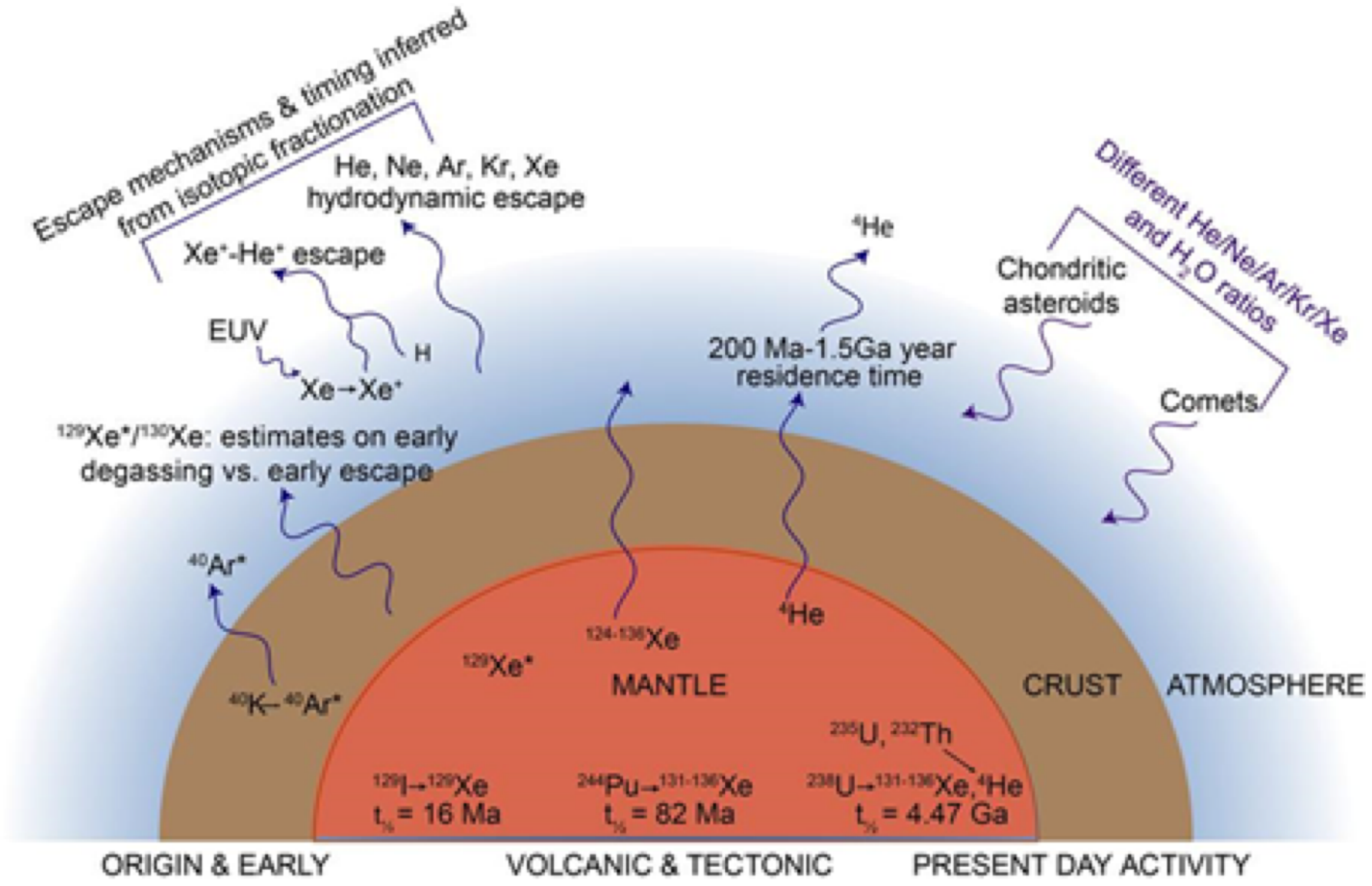
CUPID'S ARROW

Why is Venus so different than Earth?

- Address Planetary Decadal Survey Goals, specifically Objective IA: 'How did the atmosphere of Venus form and evolve'
- Measure the concentrations of noble gases and isotope ratios in Venus atmosphere @110 km (below the homopause) to provide key information on the formation and evolution of Venus.
- Noble Gases are tracers of planetary evolution
  - the supply of volatiles from the solar nebula
  - the supply of volatiles by asteroids and comets
  - the escape rate of planetary atmospheres
  - the degassing of the interior (volcanism)
  - the timing of these events



Noble gases are tracers of planetary evolution



(Pepin et al., 1991; Chassefiere et al., 2012)

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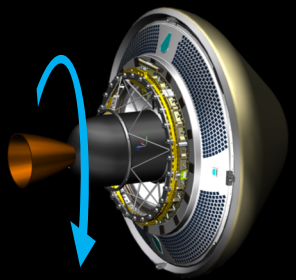
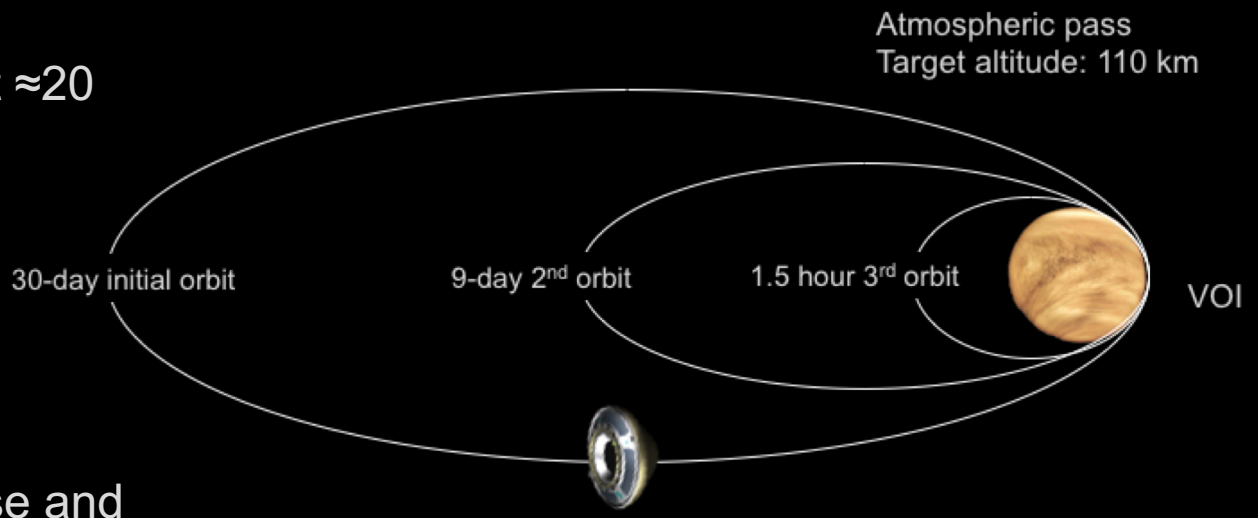
Baseline Mission

- Flight time ~430 days
- Launch in 2022, December
- Launch C3 < 9 km^2/s^2
- Arrival Vinf. = ~2.7 km/s
- Initial large elliptical orbit ≈20 days





- Spin Stabilized for cruise and atmospheric pass
- Separate solid for VOI
- DV Monoprop capability ~60 m/s (in probe)
- DV VOI Capability ~433 m/s

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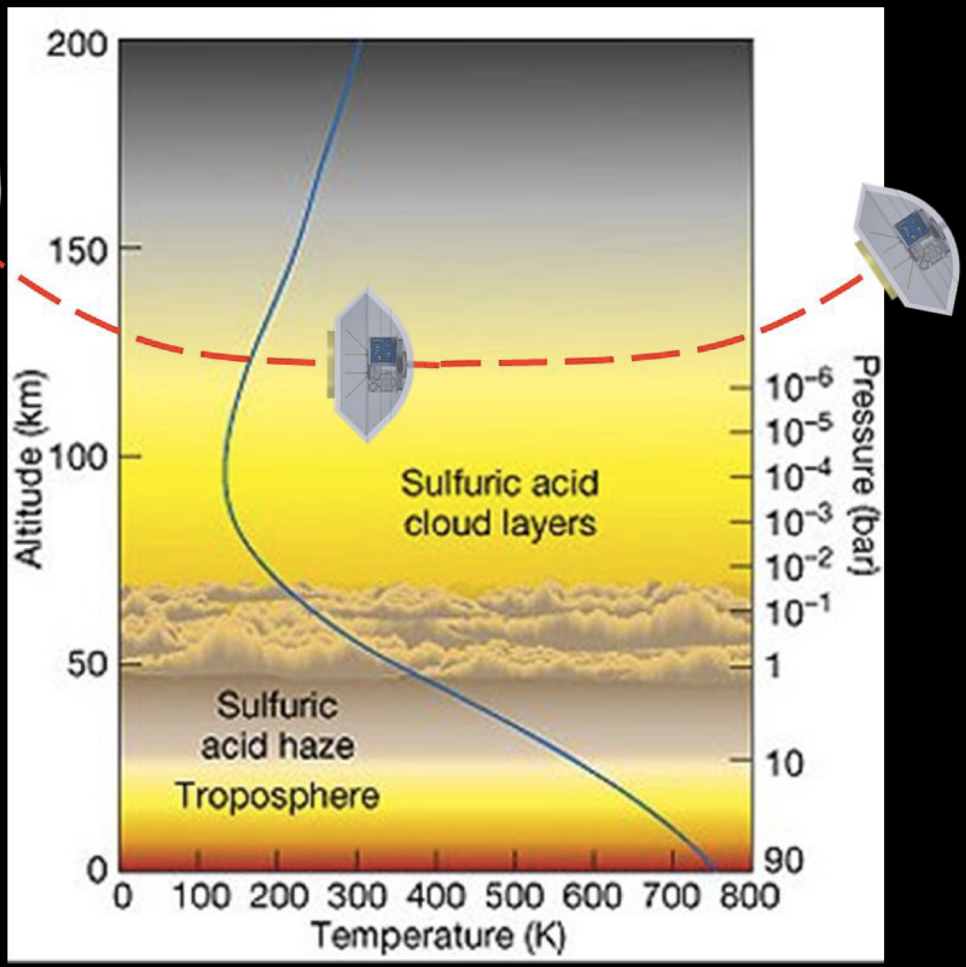
Atmospheric Entry Conditions

Entry velocity of 10 km/s
Target altitude of 110 km

Homopause is between 119 km (evening terminator) and 135 km (night side close to the morning terminator) with a weak dependence on latitude (Limaye et al., 2017)



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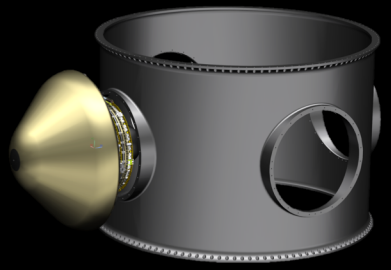
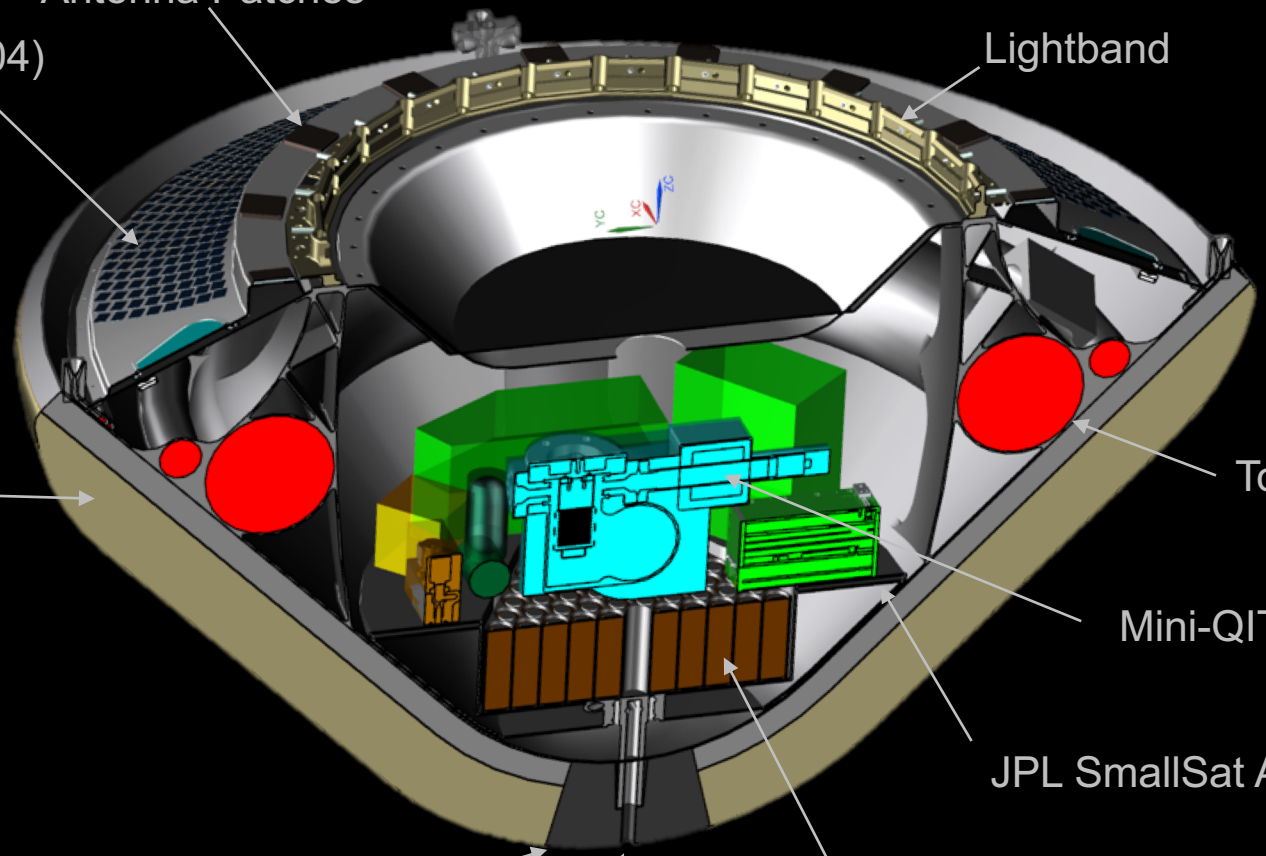
Mechanical Configuration





JPL Mini Quadra-pole Ion Trap Mass Spec (QITMS)

- No discrete wires to make electrical connections to mass spectrometer parts.
- 4 kg mass; 2U volume
- Extremely robust against shock/vibe loads
- Very stable measurements

- Each generation of QITMS is getting progressively smaller with lower mass and without compromising performance
  - 8kg → 4kg
- Builds on previous developments for HEOMD; e-Nose and VCAM.

QITMS Isotopic Precision is 3-5 times better than required

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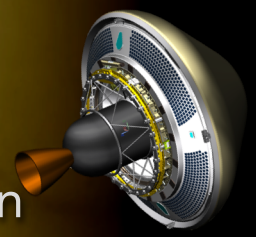
Summary

- This concept offers a new and game changing approach for atmospheric sampling at Venus
- Understanding how Earth and Venus have diverged in their geological history is a key to understanding the habitability of earth-like planets.
- A miniaturized QITMS measuring the concentrations of noble gases and isotope ratios in Venus atmosphere would provide key information on the formation and evolution of Venus.
- A free-flying SmallSat probe may be able to deliver high-priority science at Venus for a fraction of the cost of a conventional Discovery mission.



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